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Flow in the shallow mantle in the westernmost Mediterranean: insights from xenoliths in Plio-Pleistocene alkali basalts from the eastern Betic Cordillera (SE Spain)

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Peridotite mantle xenoliths in Plio-Pleistocene alkali basalts of the eastern Betic Cordillera (Cartagena area, Murcia, SE Spain) provide a snapshot of the structure and composition of the lithospheric mantle at the northern limb of the Alpine Betic-Rif arched belt in the westernmost Mediterranean. The xenoliths are spinel and plagioclase lherzolite with minor harzburgite and wehrlite, displaying porphyroclastic to equigranular textures. Regardless of composition and texture, the Crystal Preferred Orientation (CPO) of olivine shows an axial-[100] pattern characterized by a strong alignment of [100]-axes near or parallel to the peridotite lineation and a girdle distribution of [010]-axes with a maximum normal to the peridotite foliation. This CPO pattern is consistent with ductile deformation accommodated by dislocation creep with dominant activation of the high temperature {0kl}[100] olivine slip system, indicative of deformation by simple shear or combinations of simple shear and pure shear with a transtensional component. Calculated seismic properties are characterized by fast propagation of P-waves and polarization of fast S-waves parallel to olivine [100]-axis, indicating the flow direction. SKS and Pn anisotropy in the eastern Betics can be explained by a lithospheric mantle peridotite with similar fabric to the one displayed by the studied mantle xenoliths. Considering the limited thickness of the mantle lithosphere in the Betics (40-80 km), the measured azimuths and delays of SKS waves in the eastern Betics are consistent with a steeply dipping mantle foliation and a subhorizontal lineation with ENE strike. This geometry of the lithospheric fabrics implies active or frozen mantle flow with a dominantly strike-slip component subparallel to the paleo-Iberian margin. Synkinematic overprinting of mineral assemblages from the garnet-spinel to the plagioclase facies demonstrates 36-40 km uplift continuously accommodated by ductile shear thinning of the lithospheric mantle. Coeval deformation of orthopyroxene in veins of composite xenoliths, formed by reactive percolation of subduction-related Si-rich melts/fluids, suggests that this deformation occurred in the late Neogene.